CLAIMS

1. A method of obtaining tropospheric delay data for use in a satellite positioning system or GNSS comprising the steps of generating for a user location, at a location remote from the user location and from meteorological information, at least one accurate tropospheric delay value, applicable to the user location for communication as a tropospheric delay correction to a said user.

2. A method according to claim 1 comprising generating, from a first model which is known per se, a first set of approximate tropospheric delay values applicable to various user geographical locations, generating from said meteorological model a second set of tropospheric delay values that are accurate and applicable to said various user geographical locations, developing a set of delay value modifications for use with said first model so that it can provide a set of tropospheric delay values substantially in agreement with the second set, and expressing the set of modifications as a set of tropospheric delay corrections for communication to a said user.

3. A method according to claim 2 wherein the first model is based on non-meteorological parameters.

4. A method according to claim 3 wherein said non-meteorological parameters comprise at least one of time of year, latitude and altitude.

5. A method according to claim 4 wherein said non-meteorological parameters comprise at least one of longitude and time of day.

6. A method according to any one of claims 2 to 5 wherein said sets of tropospheric delay values comprises zenith tropospheric delays.

7. A method according to claim 6 wherein the first model contains a mapping function relating tropospheric delay at a given elevation angle to the zenith tropospheric delay.

8. A method according to claim 7 wherein said set of delay value modifications comprise a set of modifications for use with the mapping function of the first model.

9. A method according to any one of claims 2 to 8 wherein the modifications are the differences between corresponding values of the sets attributable to the first and meteorological models.

10. A method according to claim 9 in which the corrections are the modifications.

11. A method according to claim 9 in which the corrections are the modifications expressed as a fractional change from the values of the first set.

12. A method according to any one of claims 2 to 11 wherein the set of corrections is developed as a data array having values determined for individual grid points on the earth's surface and the set of values comprises a distribution of said modifications over at least part of the earth's surface.

13. A method according to claim 12 wherein said set of corrections is derived as a digital data file.

14. A method according to claim 13 wherein the set of modifications is derived as a set of values from which modifications applicable to points between said grid points can be interpolated or extrapolated from said set values.

15. A method according to claim 13 or claim 14 comprising applying data reduction to the correction set and deriving a reduced data set for communication to a user.

16. A method according to claim 15 comprising reducing the data size of the correction set by an image compression process.

17. A method according to claim 15 or claim 16 comprising reducing the data size by lossy data reduction.

18. A method according to claim 17 comprising effecting data reduction by reducing the correction set data file according to a JPEG 2000 or JPEG 90 standard.

19. A method according to claim 1 including providing for said derivation at least one of the user position and positions of satellites relative to the user.

20. A method according to claim 19 wherein said derivation at least one of the user position and positions of satellites relative to the user is provided by communication from the user.

21. A method according to any preceding claim wherein said accurate tropospheric delay values are derived by a ray tracing technique.

22. A method according to claim 21 wherein said accurate tropospheric delay values are derived by three-dimensional refractive index field generation.

23. A method according to any preceding claim wherein said meteorological model is based on numerical weather prediction (NWP) data for a region of the earth.

24. A method according to any one of claims 21 to 23 wherein said meteorological information or each said tropospheric delay value correction is augmented by directly observed meteorological data.

25. A method according to claim 24 wherein said directly observed data has a resolution smaller than the NWP data.

26. A method according to claim 24 or claim 25 wherein said directly observed meteorological data is derived as a data set relating to a region of the earth's surface corresponding to at least part of the NWP data.

27. A method as claimed in any one of claims 23 to 26 wherein said region is substantially global.

28. A method as claimed in any one of claims 21 to 27 comprising predicting tropospheric delay values in the future from said meteorological information and

developing a prediction set of said corrections for said geographic region of the earth's surface, whereby each member of said prediction set describes a correction that becomes current as a function of time from development.

29. A method according to any one of the preceding claims comprising communicating the correction or set of corrections to a remote user on a communication channel or data link.

30. A method as claimed in claims 29 when dependant claim 28 comprising communicating said prediction set of corrections as a batch and using members of the set as the time for which each was predicted becomes current in respect of the forecast.

31. A method according to claims 29 or 30 comprising communicating at least part of the corrections to at least one orbiting satellite and re-transmitting at least part of the set to a user from a said orbiting satellite.

32. A method according to claim 32 comprising communicating the corrections to at least one orbiting GNSS satellite from which user receives signals to establish at least one of position and time.

33. A method according to claim 31 or claim 32 comprising communicating to a said satellite for re-transmission of only that part of the correction data that can be of use to a user in a region within range of said satellite.

34. A method according to any one of claims 31 to 33 when dependant on claim 30 comprising communicating said prediction set of corrections to said at least one orbiting satellite in a batch and re-transmitting the members one at a time as the time for which each was predicted becomes current in respect of the forecast

35. A method according to any one of claims 31 to 34 comprising applying data reduction sufficient to permit transmission of all or part of a said corrections useable by a user within a time, dictated by transmission availability and

transmission rate of the satellite, substantially lower than the validity time of the meteorological information used by the meteorological model.

36. A method according to claim 35 wherein the data reduction is arranged to permit transmission of a said corrections to a user corresponding to a meteorological temporal resolution of said meteorological model information of no greater than 1 hour.

37. A method according to claim 35 or claim 36 wherein the data reduction is arranged to permit transmission of a said corrections to a user corresponding to a meteorological spatial resolution of said meteorological model information of no greater than 50 km.

38. A method according to any one of claims 35 to 37 wherein the data reduction is arranged to permit correction data transmission to a user at a data rate in the range 25 to 500 bits/s.

39. A method according to claim 38 wherein the data reduction is arranged to permit correction data transmission in the range 200 to 250 bits/s.

40. A method of correcting tropospheric delay errors in a GNSS receiver having means to derive modelled tropospheric delay values from non-meteorological parameters, the method comprising obtaining data in accordance with any one of claims 2 to 18 or any one of claims 21 to 39 dependant thereon as a set of corrections, by the use of a first model corresponding to the model in the receiver, remotely of the receiver and transmitting said set of tropospheric delay value corrections, receiving said corrections in the GNSS receiver and modifying tropospheric delay values obtained by use of the receiver modelling means in accordance with the received corrections.

41. A method according to claim 40 comprising determining within the receiver, from the non-meteorological parameters and the model, an approximation to tropospheric delay values and therefrom an approximate position of the receiver

relative to the earth's surface, and deriving tropospheric delay value modifications from the set of transmitted corrections relevant to the region including said approximate position.

42. A method of determining position of a GNSS user receiver having means to derive modelled tropospheric delay values from non-meteorological parameters, comprising determining within the receiver from said non-meteorological parameters an approximation to tropospheric delay values and therefrom an approximate position of the receiver relative to the earth's surface, deriving modified tropospheric delay values in accordance with claim 40 and therefrom determining a more accurate receiver position.

43. A method of reducing tropospheric delay errors in a GNSS having a user receiver that includes means for deriving tropospheric delay values from a non-meteorological model, the method comprising deriving, remotely of the receiver, from a comparable non-meteorological and from a meteorological model a set of corrections to the values derived from the first model for different locations about the earth's surface, transmitting the set of delay corrections to orbiting satellites and re-transmitting the corrections from said satellites to a said user receiver.

44. A method of providing tropospheric delay values to a receiver at a known location comprising deriving at a server location remote from the receiver, using information relating to the user receiver position and meteorological information, at least one tropospheric delay value applicable to the receiver location and communicating each said value to the user receiver.

45. Apparatus for obtaining data for use by a user of a satellite positioning system or GNSS, comprising generating means for generating, at a server location remote from the user from meteorological information, at least one accurate tropospheric delay value applicable to the user location and means to communicate at least a function of a said value to the user as a tropospheric delay correction.

46. Apparatus as claimed in claim 45 wherein said meteorological information is arranged to derive a set of tropospheric delay values applicable to a plurality of user locations.

47. Apparatus as claimed in claim 46 comprising first generating means for generating a first set of approximate tropospheric delay values applicable to from a first model which is known per se, second generating means for generating a second set of more accurate tropospheric delay values from a meteorological model based on meteorological information, and developing means for developing from said first and second delay sets a set of tropospheric delay value modifications for use with said first model so that it can provide a set of tropospheric delay values substantially in agreement with the second set, and said developing means being arranged to express the modifications as a set of tropospheric delay corrections.

48. Apparatus as claimed in claim 47 wherein said first generating means utilises a said first model is based on non-meteorological parameters.

49. Apparatus as claimed in claim 47 or claim 48 wherein the developing means is arranged to express said set of corrections each as a difference between corresponding values of the first and second sets.

50. Apparatus as claimed in claim 47 or claim 48 wherein the developing means is arranged to express said corrections a fractional change from the values to be corrected.

51. Apparatus as claimed in any one of claims 47 to 50 wherein the developing means is arranged to express the corrections as a distribution over a region of the earth's surface.

52. Apparatus as claimed in claim 51 wherein said region is global.

53. Apparatus as claimed in claim 51 or claim 52 in which the developing means is arranged to express the corrections in the form of a data file of a greyscale image of multi-bit words, each word representing a location of the region.

54. Apparatus according to any one of claims 47 to 53 including means for compressing said set of corrections.

55. Apparatus according to claim 54 in which the means for compressing said set of corrections comprises means to effect lossy compression on the set.

56. Apparatus according to any one of claims 47 to 55 comprising transmission means for transmitting said set of corrections to a user via an orbiting satellite.

57. Apparatus as claimed in claim 56 arranged to transmit to an orbiting satellite corrections for re-transmission to the user from that satellite and to transmit only corrections applicable to users in regions served by satellite.

58. Apparatus as claimed in claim 45 or claim 46 wherein the apparatus is arranged to receive from the user information defining at least one of the user location with respect to the server or with respect to the GNSS satellites.

59. A GNSS user receiver comprising means operable to generate from an on-board model from non-meteorological data a set of approximate tropospheric delay values and from and delay values applicable to identification signals received from a plurality of said satellites and compute an approximate position of the receiver relative to the earth's surface or time, means operable to receive a set of corrections to said tropospheric delay values derivable from the model, said corrections being derived from meteorological data, means to effect modifications to said derived delay values in accordance with the corrections and means to compute the position or time with greater accuracy.

60. A GNSS user receiver as clamed in claim 59 wherein said means to effect modification to said delay values is operable to effect interpolation or

extrapolation of said corrections according to computed position of the user relative to locations for which the corrections have been derived

61. A GNSS including a plurality of orbiting satellites, apparatus as claimed in any one of claims 37 to 57 and a user receiver according to claim 59.

62. A GNSS including a plurality of orbiting satellites, apparatus as claimed in any one of claims 45 or 58 and a user receiver at a location known with respect to the apparatus.